UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street, H-6-4
San Francisco, CA 94105

May 1, 1995

Hugo P. Fleischman
US Environmental Protection Agency
MC: 5203G
401 M Street, SW
Washington, DC 20460

RE: EPA Five Year Review for the Applied Materials Superfund Site, Region IX

Dear Mr. Fleischman:

Enclosed is the Five Year Review for the Applied Materials Superfund Site, Santa Clara, CA. You may contact me at (415) 744-2280 with any questions.

Sincerely,

Belinda Wei

Belinda Wei
Superfund Project Manager

Enclosure

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street, H-6-4
San Francisco, CA 94105-3901

MEMORANDUM

SUBJECT: Five-Year Review for the Applied Materials Building One Superfund Site, 3050 Bowers Avenue, Santa Clara

FROM: Nathan W. Lau, Acting Chief
Remedial Action Branch

TO: Keith Takata, Deputy Director
Office of Superfund Programs
Hazardous Waste Management Division

I. INTRODUCTION

Attached, please find a copy of the Applied Materials Five Year Review prepared by the California Regional Water Quality Control Board. EPA has reviewed their Five Year Review and adopts their recommendations as written. The Regional Board's Five Year Review is summarized below.

Because contaminant levels will allow for unlimited use and unrestricted exposure upon achieving ROD goals, this Five-Year Review is not required by the statute (section 121(c) of CERCLA, as amended) or Section 300.430(f)(4)(ii)) of the NCP, which implements CERCLA. However, because clean-up will take five or more years to attain, this Five-Year Review must be conducted as a matter of Agency policy (OSWER Directive 9355.7-02, "Structure and Components of Five-Year Reviews", 5/31/91, p.2). This review (Type I) is applicable to a site at which construction is complete (OSWER Directive 9355.7-02A, "Supplemental Five-Year Review Guidance", 7/26/94, p.4-5).

II. FIVE YEAR REVIEW SUMMARY

The Applied Materials Building One site was listed on the NPL in May 1987. In 1983, the source was found to be a nest of three underground acid neutralization tanks beneath a concrete equipment pad on the west side of Building One. Applied Materials began interim clean-up measures that year until 1990. These interim measures included installing a groundwater extraction and treatment system, and excavating and removing the tanks and 60 cubic yards of soil. The main contaminants of concern were 1,1,1-TCA, 1,1-DCE, and 1,1-DCA, and the contaminants spread to the 'A-zone' and 'A2-zone' aquifers. On September 28, 1990, the first Record of Decision was signed, selecting groundwater extraction and treatment to MCLs as the remedy. Evaluation of the soils was left for the Final Record of Decision. On August 25, 1993 that Final ROD was signed declaring that no further remedial action was

needed for soils. The unsaturated soils near the surface were not contaminated, and the contaminated soils located at a depth of 20 feet to 30 feet in the saturated zone would be treated by the pump and treat system. However, it was decided that the first five year review would evaluate whether the system was effectively reducing the contamination in the soils or if it was necessary to consider removing the contaminated soils when Building One was no longer in use or would be torn down.

Since 1985, the groundwater extraction and treatment system has treated approximately 61,200,000 gallons of water and removed approximately 234 kg (515.81 lbs) of VOCs. MCLs for 1,1,1-TCA in the upper zone, the 'A-zone' have been attained. The pump and treat system, which consists of two A-zone wells and one A2-zone well, has effectively reduced VOC concentrations and contained the plume. Applied Materials feels their site is close to reaching asymptotic levels and requested the Regional Board to apply its "Non-Attainment Area" policy to the site. The Regional Board felt their request was not complete and will evaluate such request outside of the Five Year Review.

It is not practical at this time for Applied Materials to attempt to remove the polluted soils beneath the building. The groundwater extraction system is adequately remediating the contaminants in the soils, and such soil removal would be too costly and would not bring about substantial reduction in clean-up time.

Since the 1990 ROD, the only change in ARARs was in the levels for 1,1,2-TCA. Its stricter level of 3 ppb, based on a new EPA MCLG, was already incorporated in the 1993 Final ROD.

III. CONCLUSION

The response actions as selected in the ROD remain effective at protecting human health and the environment (OSWER Directive 9355.7-02, Attachment I, p.2).

Future Policy Five Year Reviews shall be conducted every five years from the approval of the previous Review, until ROD cleanup levels are achieved, assuming they will remain at levels that allow for unlimited use and unrestricted exposure (OSWER Directive 9355.7-02, Attachment I, p.5). Therefore, the next Five Year Review shall be written five years from the signature date of this Review.

Approved by: Keith Takata Date: 4-28-95

Keith Takata, Deputy Director
Office of Superfund Programs
Waste Management Division
Region IX

Attachment: Review Comments on Applied Materials Building 1 Facility, 3050 Bowers Avenue in Santa Clara, Five-Year Status Report and Effectiveness Evaluation

cc: Applied Materials Site File

MAIL CODE	H-6-4	H64	H-6			
SURNAME	B. Wei					
DATE	4/21/95	4/24/95	4/24/95			

U.S. EPA CONCURRENCES OFFICIAL FILE COPY

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

INTERNAL MEMO

TO: Steven R. Ritchie
Executive Officer

Date: April 6, 1995

FROM: Tony Mancini
Asso. EG

SUBJECT: Review Comments on Applied Materials Building 1 Facility, 3050 Bowers Avenue in Santa Clara, Five-Year Status Report and Effectiveness Evaluation

CONCUR:

Anders G. Lundgren
Section Leader

Stephen I. Morse, Chief
Toxics Cleanup Division

Applied Materials (AM) has submitted its first Five-Year Status Report and Effectiveness Evaluation for the Building 1 Facility at 3050 Bowers Avenue in Santa Clara. AM has been remediating soil and groundwater contamination at the Building 1 Facility for more than five years. A Final Cleanup Plan was adopted in SCR Order 90-134, which amended SCR Order 89-167, and which in turn was amended by SCR Order 93-056. The U.S. EPA issued a ROD for a site groundwater operable unit on 9/28/90, and a Final Rod on 8/25/93. A Superfund Preliminary Close Out Report was issued by the EPA on 9/27/93. Concentrations of volatile organic compounds (VOCs) have declined substantially since the initial discovery, although one "hot spot" persists. The chemical plume appears to be contained by three "A-aquifer" extraction wells, including one at the downgradient property boundary. The Responsible Party (RP), herein called the Discharger, estimates that the established remedy may achieve cleanup standards over the entire site by year 2006. The Discharger also proposes application of the Regional Board's Non-Attainment Area (NAA) concept to this site. The State Water Resources Control Board (SWRCB) is proposing a revision of Resolution No. 92-49 to include a provision and process for the establishment of "non-attainment zones"; "non-attainment areas", or "Non-Attainment Area" as used herein, means the same as "Non-Attainment Zone" in the proposed revision to Resolution 92-49. The approach being taken by the SWRCB and this Regional Board in making it possible to propose the application of approved criteria to establish "Non-Attainment Zones" or "Non-Attainment Areas" is similar to the U.S. EPA's approach for evaluating the technical impracticability of groundwater restoration.

I recommend no changes in Board SCR Orders for this site at this time, but I do recommend that the NAA proposal be considered separately from the Five-Year Status Report and Effectiveness Evaluation. The complete Staff Review of AM's Five-Year Status Report and Effectiveness Evaluation is attached.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

Toxics Cleanup Division

Five-Year Review (Type I)

Applied Materials, Inc. Building 1 Facility
3050 Bowers Avenue
Santa Clara, California

I. INTRODUCTION

Authority Statement. Purpose. The California Regional Water Quality Control Board, San Francisco Bay Region, conducted this review pursuant to the Multi-Site Cooperative Agreement (MSCA) between the U.S. EPA Region IX and the Regional Board, and the U.S. EPA Supplemental Five-Year Review Guidance (OSWER Directive 9355.7-02A) of July 26, 1994. It is a policy review. The purpose of a five-year review is to ensure that a remedial action remains protective of public health and the environment and is functioning as designed. This document will become a part of the Site File (No. 2189.8152). This review (Type I) is applicable to a site which is construction complete.

Site Characteristics:

Location. The Building 1 facility is located on what has come to be called the AM "campus", whereon a number of other buildings have been constructed and/or purchased by AM. The campus is bounded in the downgradient direction by Scott Boulevard on the north, and Bowers Avenue on the east. The predominant groundwater flow direction is towards the northeast. The geologic interval being remediated is unconsolidated sands/gravels/silts/clays of the "A zone", encountered at depths of 20-25 feet below the surface. Groundwater in the underlying "B zone", reached at a depth of about 48 feet, has minor VOC contamination, and is being monitored but not remediated. Immediately downgradient to the east, on the other side of Bowers Avenue, is the Hewlett-Packard Company (formerly Avantek) site which is also undergoing active site remediation because of Avantek's past discharge of VOCs to the subsurface. Adjoining the Building 1 site on the north is a former Hewlett-Packard (H-P) site, now the location of AM Building 3. Between Buildings 1 and 3 is the newly constructed AM Building 2A. Building 2A occupies a portion of the Building 1 site included in the RI/FS report and the deed restrictions document (refer to Figures 1 and 2 attached). Because of the relatively recent new construction in the vicinity of Building 1, a number of original monitoring wells were destroyed and replaced with others. VOC pollution in groundwater has been detected on the former H-P property adjoining the Building 1 site on the north, but an on-site source has not been located. It has been postulated that an off-site source is responsible for the pollution on the former H-P site. The VOC concentrations have been declining and site remediation has not been required. To the west of Building 1 are other AM facilities on the AM campus; further westward is more developed real estate, and the AM campus is bounded on the south by Central Expressway.

Source of contamination. The Building 1 site has been occupied and operated by AM since about 1970. The source of contamination at the Building 1 site was discovered to be a nest of three underground acid neutralization tanks beneath a concrete equipment pad on the west side of Building 1, by the installation

and sampling of downgradient "A-zone" groundwater monitoring well AM1-1 in 1983. VOC concentrations in the shallow A aquifer, at a depth of about 20 to 25 feet, in 1983 were about 14,000 ppb 1,1,1-TCA (which increased to 44,000 ppb in 1985), 3,400 ppb 1,1-DCE, and 1,100 ppb 1,1-DCA . In 1985 the tanks and about 60 cubic yards of soil were excavated and removed. The excavation was backfilled and converted into a groundwater extraction pit, well AM1-1 was converted to an extraction well, and one other "A-zone" extraction well (well AM1-5E) was installed very close to the downgradient property boundary along Bowers Avenue. In 1990 "A2-zone" extraction well AM1-10 was installed in the vicinity of a perceived "hot spot" near the location of a former underground tank, to remediate VOC pollution in "A-zone" groundwater in the 30 to 38-foot depth interval. Although a dozen or more chemical pollutants have been detected in soil and groundwater of this site, the "signature VOCs" for the site are identified by the Discharger as 1,1,1-TCA, 1,1-DCA, and 1,1-DCE. The highest concentrations have been of 1,1,1-TCA; 1,1-DCA and 1,1-DCE reportedly are degradation products of 1,1,1-TCA, and during early cleanup activities a direct relationship reportedly existed between the concentration of 1,1,1-TCA in groundwater and the concentrations of 1,1-DCA and 1,1-DCE. Vinyl chloride has been detected, but not consistently.

Maximum contamination. The historical maximum total VOC concentration in the "A zone" was from a groundwater sample collected from the extraction pit (AM1-EP, 6 Feb. 1985) and contained more than 400,000 ppb, consisting of: 1,1,1-TCA @ 370,000 ppb; 1,1-DCE @ 19,000 ppb; 1,1-DCA @ 13,000 ppb; 1,2-DCA @ 560 ppb; 1,1,2-TCA @ 190 ppb; TCE @ 70 ppb; and vinyl chloride @ 18 ppb. The maximum total concentration of VOCs measured in "A-zone" soil was about 65 mg/kg, from a 17-foot-depth sample in the same general area as AM1-EP, and consisted of 57 mg/kg 1,1,1-TCA; 4.1 mg/kg 1,1-DCA; 3.5 mg/kg 1,1-DCE; 0.13 mg/kg 1,2-DCA; 0.14 mg/kg TCE; and 0.17 mg/kg PCE. When this sample was collected (1985), the water table reportedly was at a depth of about eight feet below the surface. Thus, the concentrations represented VOCs in saturated soil. More recently the maximum VOC concentrations in groundwater from well AM1-10 ("A2 zone") were 60,000 ppb 1,1,1-TCA, 4,800 ppb 1,1-DCA, and 2,700 ppb 1,1-DCE. Other VOCs detected were vinyl chloride (8.3 ppb), PCE (160 ppb), 1,2-DCA (27 ppb), TCE (24 ppb), and 1,1,2-TCA (35 ppb). A less-significant amount of VOC pollution has been detected in the underlying "B zone". Remediation of the "B zone" has not been required.

II. DISCUSSION OF REMEDIAL OBJECTIVES; AREAS OF NONCOMPLIANCE

Interim Remedial Actions:

Underground Tanks and Soil. Soon after groundwater pollution by VOCs was confirmed, the Discharger excavated and removed a nest of three underground acid-neutralization tanks on the west side of Building 1, along with about 60 cubic yards of polluted soil. The Discharger evaluated five alternative cleanup proposals in the RI/FS Report and determined that "A-zone" groundwater extraction and treatment was the most feasible alternative. The Discharger also considered additional soil removal in conjunction with groundwater extraction, if Building 1 was found to be unusable in the future and permanently vacated. Although the use of Building 1 has changed, it does not appear that the building will be permanently vacated in the near future, and soil remediation does not seem practical.

Groundwater. Extracted groundwater initially was treated by activated carbon, for a relatively short period, after which treatment was, and continues to be, by air stripping. The original air stripper was replaced recently (1994) with a newer model. Groundwater is extracted only from the "A zone" and the

"A2 zone", at an average combined rate of about 15 gpm. Currently, 1,1,1-TCA in the upper "A zone" groundwater is the only VOC (excluding Freons) which has a concentration below the drinking water MCL.

Applicable and Relevant and Appropriate Requirements (ARARs). The three general categories of ARARs as applicable to this site are adequately discussed in the 9-28-90 ROD. Since the ROD was adopted, there has been one change in the Chemical-Specific ARARs: the ARAR for 1,1,2-trichloroethane (1,1,2-TCA) shown as 5 ppb (U.S. EPA MCL) and 32 ppb (CA DHS MCL) in the ROD, is currently established at 3 ppb by Board Order 93-056. The basis for this new ARAR is the 3 ppb MCLG for 1,1,2-TCA adopted by the U.S. EPA and enforced beginning January 1994. There are no other changes to ARARs as presented in the ROD.

Board Actions:

NPDES Permit. In 1985 the Board adopted a site specific NPDES permit for the site, for the discharge of 52,000 gpd treated groundwater to the storm-sewer-system. This permit was renewed in 1990 for a discharge of up to 50,000 gallons per day of treated groundwater. More recently (late 1994) the site specific permit was rescinded and replaced with a general waste discharge (NPDES) permit, for discharge of treated extracted groundwater to the storm sewer.

Site Visit. The most recent site visit occurred December 1, 1994, at which time a compliance inspection was conducted by a member of the Board's Staff. The inspection did not reveal any violations of site cleanup requirements, and the site was found to be in full compliance. The Inspector confirmed that the original air stripper in the treatment compound had been replaced with a new air stripper. Water samples were collected of the groundwater influent to and effluent from the air stripper for analysis. The reported results were:

	Concentration (ppb or ug/L)	
Constituent	Influent	Effluent
1,1-DCA	25	ND(0.5)
1,1-DCE	40	ND(0.5)
PCE	0.6	ND(0.5)
1,1,1-TCA	38	ND(0.5)
TCE	3.1	ND(0.5)
F-113	11	ND(0.5)
Vinyl Chloride	0.7	ND(0.5)
1,2-DCA	ND(0.5)	ND(0.5)
1,1,2-TCA	ND(0.5)	ND(0.5)
F-11	ND(3.0)	ND(0.5)

The Discharger has complied with requirements of local government and has installed valves at two places in the storm sewer on-site for the purpose of controlling and containing any accidental surface spills. Procedures for coordinating the operations of the extraction and treatment systems with operations of these valves have been developed, and a modified air stripper O & M plan has been prepared. Institutional controls, in the form of Deed Notice/Restrictions, are in effect.

Site Cleanup Requirements. In 1986 the Board adopted waste discharge requirements for site cleanup. This Order (86-71) was rescinded by SCR Order 89-167, which included a Final Cleanup Plan and Final Cleanup Levels for VOCs in groundwater. Following revisions in SCR Orders 90-134 and 93-056, Final Cleanup Levels for groundwater are:

Cleanup Levels (ppb)	Carcinogen	Non-carcinogen
5	1,1-DCA	
0.5	1,2-DCA	
6	1,1-DCE	
5	PCE	
5	TCE	
3	1,1,2-TCA	
0.5	Vinyl chloride	
6	Chloroform	
1,200		Freon-113
150		Freon-11
200		1,1,1-TCA
6		cis-1,2-DCE
10		trans-1,2-DCE

The final cleanup level for soil was set at 1 ppm total VOCs.

Final cleanup plan. The final cleanup plan adopted by Board Order (1990) consists of:

1. Continued groundwater extraction until VOC concentrations are reduced to acceptable cleanup standards.

2. Remediation of soils containing more than 1 ppm total VOCs if site conditions make remediation practical.

3. Reclamation and/or reuse of 100% of the groundwater that is extracted and treated, if feasible.

4. Implementation of institutional controls, such as deed restrictions.

5. A long-term groundwater monitoring program, and the submittal of periodic reports concerning the status of site remediation.

This plan was modified slightly in 1993, as proposed by the Discharger, to defer consideration of any requirement for the direct remediation of polluted soil until the five-year status report is reviewed and the efficiency of the groundwater extraction system is evaluated.

A Summary of the Discharger's Five-Year Status Report and Effectiveness Evaluation:

Discharger's Evaluation. The 5-year status report is the Discharger's evaluation of the selected final cleanup remedy and cleanup costs. This report also contains an evaluation by the Discharger, if safe drinking water standards have not been achieved, addressing whether it is technically feasible to achieve drinking-water quality on-site, and if so, a proposal for procedures to do so.

Effectiveness of site remediation. About 60 cubic yards of polluted soil were removed in 1984 when the three underground tanks were removed. Additional soil has not been removed because of a perceived threat of serious damage to Building 1 which could result from additional soil removal. Since groundwater pumping from the "A zone" began in 1985, approximately 61,200,000 gallons of groundwater have been extracted and treated, and approximately 234 kgs (515.81 lbs) of VOCs have been removed (August 1985 - July 1994). About 188 kgs were removed during the first four years; the remaining 46 kgs were removed during the 5-year review period (mid-1989 to mid-1994). The extraction/treatment systems currently remove about 6 kgs/yr compared to about 150 kgs removed during the first year of operation. Groundwater extraction is effectively reducing the concentrations of VOCs, and containing the plume on-site. Extraction from all extraction wells is reducing VOC concentrations, and extraction from well AM1-5E captures A-zone groundwater in the vicinity of the downgradient property boundary and contains the plume.

VOCs remaining on-site. The steady decrease in plume concentration with continued groundwater extraction indicates, as stated by the Discharger, that any undetected VOC mass which may be present has not hindered cleanup progress and therefore is not significant. In May of 1992 the total VOC mass remaining was calculated to be about 24 kgs. A re-calculation for the 5-year review indicated, as of mid-1994, about 19 kgs remaining. It has been concluded that the VOCs remaining in soil are of very limited extent and do not constitute a significant residual source of VOCs to groundwater. Even the source of the "hot spot" in the vicinity of well AM1-10 is limited (and is effectively being removed). The Discharger has determined that VOCs are sorbed onto soil particles below the water table at concentrations greater than 1 ppm, and total about 1.52 kg, but this is not considered significant. Soil excavation to remove soils at concentrations above the total VOC 1 ppm cleanup standard is estimated to cost at least $3,800,000, and would be of minimal benefit because this would enhance cleanup time by only a few years.

Some DNAPL may be present, but not in significant amounts and not in localized concentrated pockets; the nearby VOC source to well AM1-10 may include DNAPL. The Discharger estimates that groundwater pumping from 1985 to mid-1994 has removed 96-99% of the VOCs in the shallow A zone; pumping since 1990 has removed about 78% of the VOCs in the A2 zone.

Extrapolated cleanup times for the remaining VOCs in site groundwater are estimated to be 6 years for well AM1-1 ("source-area well") and 12 years for well AM1-5E ("downgradient well"). The concentration of 1,1,1-TCA is currently below the MCL in wells AM1-1 and AM1-5E. For well AM1-10 ("A2-zone well") the cleanup time is estimated to be about 11 years.

Water reuse. With additional treatment to reduce dissolved solids and total hardness, the extracted groundwater could be used in scrubbers and cooling towers, and for lawn irrigation. However, the initial capital and operational costs could be significant. All of the extracted groundwater could be used in cooling towers at maximum demand (or 70% on average). Scrubbers at Buildings 1 and 2 use almost 15 gpm city water (some of this water is recirculated). The facility uses more than one million gallons of city water per year for lawn irrigation. The Discharger estimates that treating groundwater for reuse in cooling towers or scrubbers, or for irrigation, would be eight times as costly as buying city water. (City water reportedly costs $1.07/100 cubic feet. Assuming a 20-year life for the treatment system, treatment costs would be $8.55/100 cubic feet.) The Discharger claims that discharge of treated extracted groundwater to the surface is a beneficial use of the groundwater.

Cost evaluation. Prior to the 5-year review period, the Discharger's costs for site investigation and interim remedial actions totalled about $1,000,000. For the 5-year review period (September 1989 to August 1994) actual total costs were:

- Monitoring	$185,000
- Extraction and treatment	95,000
- Miscellaneous (general consulting services, special studies/ reports)	475,000
(regulatory oversight-est.)	325,000
- Capital expenditures (replace air stripper)	25,000
- Reporting	215,000
Total	$1,320,000

The Discharger's reported grand total cost to remediate the site thus far amounts to about $2,320,000. Projected future costs (i.e., total cost to reach MCLs), in 1994 dollars, are estimated to be from $967,000 to $1,236,000, or, about $1,000,000 for a 12-year project life ($103,000 annually). If cleanup time is longer than 12 additional years, the total cost will be greater.

Evaluation of cleanup goals. The Discharger claims that site groundwater is not suitable for domestic use, may be limited for livestock use, and is unsuitable for most industrial uses; and that MCLs are unduly low as cleanup goals for the groundwater because of the remote likelihood that the shallow groundwater would ever be used domestically and the extremely remote likelihood that VOCs would ever migrate to the deeper drinking water aquifers. Shallow groundwater leaving the site will almost certainly never be used domestically; and if it were, the excess cancer risk (calculated by the Discharger) would be only about 5×10^{-6} to 9×10^{-6}. The Discharger also claims that the expenditure of resources to reach MCLs in "A-zone" groundwater is not warranted, and, cleanup levels/goals should be based on a risk analysis. The Discharger's proposed cleanup goals for some VOCs are considerably higher than MCLs at the downgradient site boundary.

Proposal to establish non-attainment area (NAA). The Discharger believes recent data indicate that concentrations of VOCs may be approaching asymptotic levels and recommends a NAA designation for the subject site and changing groundwater cleanup goals at the downgradient site boundary from MCLs to acceptable risk-based levels (shown below - MCLs are shown for comparison). A proposal for applying the NAA designation, including a monitoring and contingency plan, has been submitted as part of the subject status report.

VOC	Proposed Cleanup Goal (ppb)	MCL (ppb) (From Board Orders)
1,1-DCA	30	5
1,2-DCA	3.0	0.5
1,1-DCE	30	6
1,2-DCE		
cis	6	6
trans	10	10
PCE	5	5
1,1,1-TCA	200	200
1,1,2-TCA	5	3*
TCE	7	5
F-113	1,200	1,200
F-11	150	150
Chloroform	6	6
Vinyl chloride	0.5	0.5

*The U.S. EPA has adopted an MCLG of 3 ppb for 1,1,2-TCA, and this becomes the cleanup standard, even though the CA MCL currently is 5 ppb. Refer to Order No. 93-056.

If approved by the Board, the extraction system will be turned off and a modified monitoring program implemented. A contingency plan will be activated if a concentration at or exceeding an established "trigger concentration" is detected in any of the monitored wells. If the trigger concentration is confirmed, a remedial action consisting of resumed groundwater extraction and treatment from one or more of the three extraction wells will be initiated, and will continue until all concentrations are below trigger concentrations for three consecutive quarters.

Staff Comments:

Staff Review. A review of the cleanup efforts since the Final Cleanup Plan was adopted in 1990 reveals that:

1. ***Groundwater remediation.*** The selected remedy consisting of the extraction and treatment of polluted groundwater (and discharge of treated water) has been implemented by the operation of three extraction wells (extraction from a fourth well, AM1-EP has been discontinued), and an air stripper, replaced in 1994. The goal of the remedy was to restore groundwater to its potential beneficial uses. The historical records from this and numerous other sites indicate that

groundwater extraction has been and is much more successful in containing pollutant plumes than in restoring groundwater to background, or even drinking water quality. The Discharger has submitted information to show that the MCL for 1,1,1-TCA has been achieved at this site; Freon-113 and Freon-11 concentrations are also below their respective MCLs. The impacted groundwater may be completely restored to drinking water quality sometime early in the next century, at an additional cost of about $1,000,000; this is based on a premise that the concentrations of specific VOCs in groundwater will continue to decline at an annual rate approximating the rate of previous (early) years. In 1993 the Discharger's cleanup time estimate included any potential effects of DNAPL and/or sorption. However, groundwater extraction may take longer than 12 years to achieve MCLs throughout the site.

2. ***Non-attainment area.*** It may not be feasible in all cases to restore VOC-polluted groundwater to background or even drinking water quality. The Regional Board came to this conclusion in 1992 and made it possible for Dischargers to propose the application of certain Board-approved criteria to sites being remediated which could result in sites being categorized as Non-attainment Areas (NAAs), which are limited groundwater pollution zones where concentrations are above water-quality objectives. The AM Building 1 site, where a Board-approved cleanup program has not yet resulted in compliance with water quality objectives, is classified as a "Category II" site for NAA consideration. The Board-approved criteria and applicability to the Building 1 site are:

a. *An appropriate cleanup program has been fully implemented and reliably operated for an adequate period of time.*

Groundwater extraction and monitoring have been in continuous operation since mid-1985, resulting in the removal of more than 500 pounds of VOC pollutants. Some remaining VOC pollution in soil may continue to impact groundwater quality, but it is not practical to attempt to remove this polluted saturated soil. Similarly, there may be "pockets" of DNAPL of limited extent which could contribute to VOC pollution in groundwater over a long period of time, but it is not practical to attempt to find and remove this DNAPL.

b. *Groundwater pollutant concentrations have reached asymptotic levels using appropriate technology.*

The concentration of 1,1,1-TCA has declined to less than its MCL in the upper "A-zone" aquifer; concentrations of the other two "signature" VOCs for this aquifer are not yet asymptotic but may be approaching asymptotic levels.(See attached Figures 3, 4, and 5.) VOC concentrations in the "A2-zone" groundwater are still declining; none of the "signature" VOCs have as yet reached a concentration approximating its MCL. However, "A2-zone" groundwater pollution appears to be limited to the vicinity of the former underground ANS tanks.

c. *Best economically available technologies are not technically or economically feasible to achieve further significant reduction in pollutant concentrations.*

Based on AM's analysis, the application of other technologies (at least one) could result in further reduction in pollutant concentrations, but costs would be prohibitive and the

expenditures are not warranted because AM's operations would be greatly disturbed and the time to achieve cleanup objectives would be shortened by only a very small amount.

d. *An acceptable plan is submitted and implemented for containing and managing the remaining human health, water quality and environmental risks posed by residual soil and groundwater pollution. This includes deed restrictions, a contingency plan, and a monitoring program.*

AM's plan for managing the remaining risk consists of deed restrictions, which are already in place, establishing revised cleanup goals based on the results of a risk-based assessment, a contingency plan, and a monitoring program. The nucleus of the plan is a suite of revised cleanup goals (standards) for groundwater, applied at the downgradient site boundary. Three of the revised standards are considerably higher than MCLs: 1,1-DCA @ 30 ppb (vs. an MCL of 5); 1,1-DCE @ 30 ppb (vs. an MCL of 6); and 1,2-DCA @ 3 ppb (vs. an MCL of 0.5). Two other revised standards are somewhat higher than MCLs: TCE @ 7 ppb (vs. an MCL of 5); and 1,1,2-TCA @ 5 ppb (vs. an MCLG of 3). The exposure scenario which was evaluated in AM's risk assessment pertained to residential exposures associated exclusively with use of AM downgradient site boundary groundwater, whereby an individual would be exposed to VOCs via direct ingestion of groundwater and inhalation of VOCs that volatilize from the water. The total excess lifetime cancer risk calculated by AM is 8.7×10^{-6}, which is within the acceptable range of 10^{-4} to 10^{-6}.

The risk numbers calculated by AM, if they approximately equate with asymptotic VOC concentration values, might be applicable to the near-source area as "trigger concentrations", but cannot be used to replace MCLs as cleanup standards. To adopt AM's proposal would not be consistent with the NAAs already established by this Board, which have downgradient boundary cleanup goals (standards) set so as not to exceed drinking water MCLs and thus protect beneficial uses.

AM's proposal may be feasible if off-site long-term monitoring points can be established in the downgradient direction to show that the pollutant plume is contained (even if it extends off-site) and VOC concentrations in groundwater at compliance points (again, off-site locations) do not exceed MCLs. By inference, downgradient property owner(s) would have to be in agreement with AM's proposal. The proposal needs to undergo further review and refinement by AM, and resubmitted if AM is still interested in applying the NAA concept to this site.

3. ***Soil remediation.*** Remediation of all soils containing more than 1 ppm total VOCs has not been attempted. Additional soil surveys indicated the presence of VOCs in fine-grained saturated sediments of the "A-zone" aquifer under the concrete equipment pad and probably extending beneath Building 1. Removal of this polluted soil was not considered practical at the time the Order was adopted, but it was suggested that soil removal might become practical at some later date. An Order adopted in 1993 amended the Order of 1990 and included a finding which stated that consideration of any requirement for the direct remediation of polluted soil under the pad and building would be deferred until the five-year status report was reviewed.

If groundwater levels were to decline substantially because of a severe drought or other reason, and/or Building 1 and the equipment pad were demolished, it could be advantageous to make a geotechnical investigation of remaining VOCs in soil, and implement cleanup actions considered appropriate. Under current conditions, there is no reason to propose that direct remediation of soil beneath the pad and building be undertaken.

4. ***Groundwater conservation.*** Groundwater conservation has not been implemented. Reclamation and/or reuse of 100% of the treated extracted groundwater was an objective of the Final Cleanup Plan. The Discharger investigated this requirement and reported that, even though it was technically possible to use the groundwater on-site, the cost of treatment to make the water usable was eight times the cost of buying municipal water and it was not practical to use any of the extracted water. Reclamation (re-injection) was also found to be impractical by the Discharger. The Discharger contends that the discharge of treated groundwater to the South San Francisco Bay is a beneficial use.

Notwithstanding AM's contention, the discharge of treated extracted groundwater to San Francisco Bay is not listed as a beneficial use in the Basin Plan and/or associated documents. It is technologically feasible for AM to use just about all of the extracted groundwater on-site, but there is a monetary cost involved. It is not practical for AM to use the extracted groundwater now, but it may become practical during a period of severe drought.

5. ***Deed restrictions.*** Institutional controls in the form of deed restrictions for the AM property have been filed by the Discharger and are in place.

6. ***Monitoring.*** A groundwater monitoring program is in effect and periodic reports are being submitted to the Board.

Staff Conclusions and Areas of Noncompliance:

1. The Discharger is in compliance with all requirements of current Board Orders, and there are no areas of noncompliance. In general, Board Staff agrees with AM's evaluation that groundwater extraction is effectively reducing the concentrations of VOCs and containing the plume on-site, but does not agree with AM's proposal to categorize this site as a Non-Attainment Area (NAA). Staff does not agree with AM's proposal to establish groundwater cleanup goals higher than drinking water MCLs at the downgradient site boundary (as part of the NAA proposal). Staff also believes AM could make a more positive effort to re-use extracted groundwater.

2. Restoring shallow groundwater to background water quality most likely is not possible, but further site remediation by groundwater extraction probably can be accomplished; the effort will be slow and expensive, continuing to year 2006 (or beyond) and costing at least an additional $1,000,000. AM had recommened continuing groundwater extraction until MCLs were achieved, as the final remedy for this site, but now believes that a NAA designation would be appropriate and has made a proposal, included with the Status Report, to designate the Building 1 site as a NAA.

3. The NAA proposal by AM is not completely acceptable as submitted. The element needing major refinement is the proposed application of cleanup standards higher than MCLs at the site's downgradient boundary.

4. It is not practical at this time for AM to attempt to remove polluted soil or to find and remove any DNAPL which may be present.

5. It is technologically feasible for AM to use all or almost all of the extracted groundwater on-site, but it is not practical because the cost of treating the water prior to use, compared to purchasing municipal water for industrial and lawn-irrigation uses, is expensive.

III. RECOMMENDATIONS

1. AM should continue site remediation by groundwater extraction and treatment and surveillance of remediation progress and effectiveness by periodic monitoring of the influent to and effluent from the treatment system and condition of site groundwater. The Board recommends no change in Site Cleanup Orders at this time.

2. The NAA proposal should be considered separately from the Status Report and Effectiveness Evaluation.

3. AM should re-examine the NAA concept and if AM still believes the concept can be applied to the Building 1 site, then AM should resubmit a revised proposal as a separate document.

4. The Board should accept the Status Report and Effectiveness Evaluation without accepting the NAA proposal as part of it (i.e., excluding the NAA proposal).

IV. STATEMENT OF PROTECTIVENESS

We certify that the remedy(ies) selected for this site remain protective of human health and the environment.

V. NEXT FIVE-YEAR REVIEW

The next five-year review report will be completed by the Discharger and submitted to the Board by October 1, 1999.

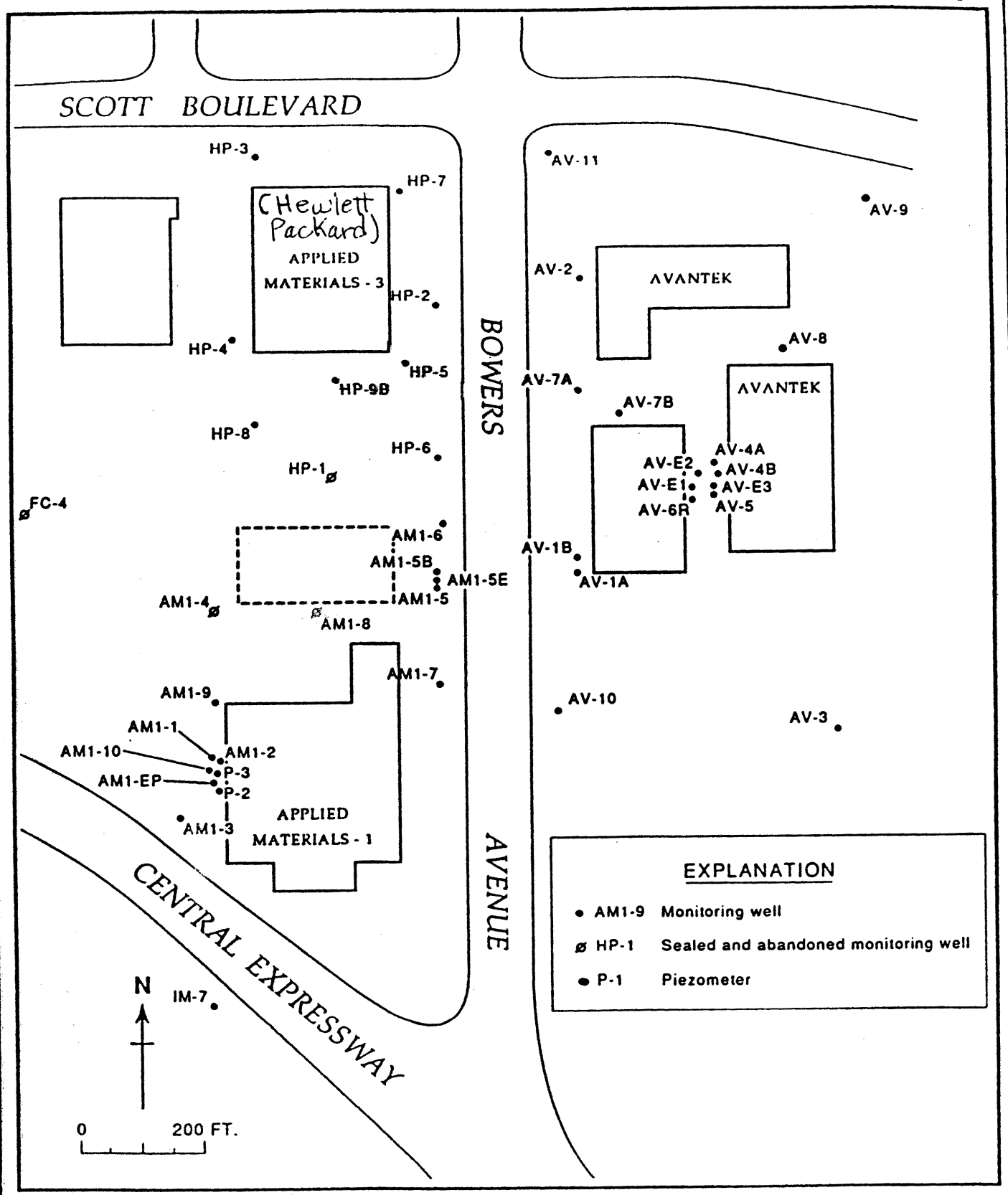

Figure 1. Wells in the Vicinity of Applied Materials Building 1

1988-1989

7/9/90

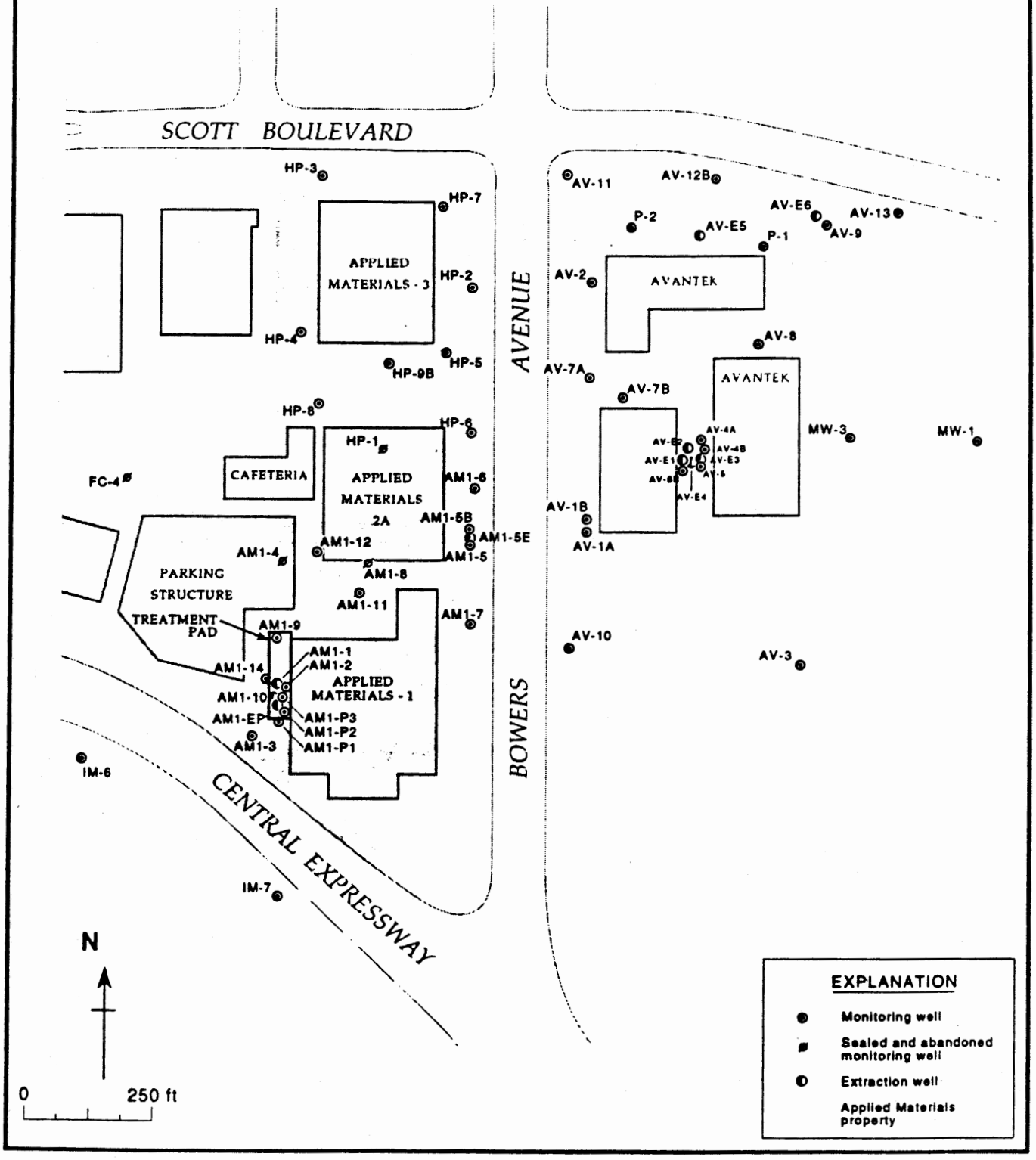

Figure 2 Well Locations - Applied Materials Eastern Bowers Campus and Vicinity, Santa Clara, California

Circa 1991 and later

Applied Materials Well AM1-1
Relative concentration vs. time

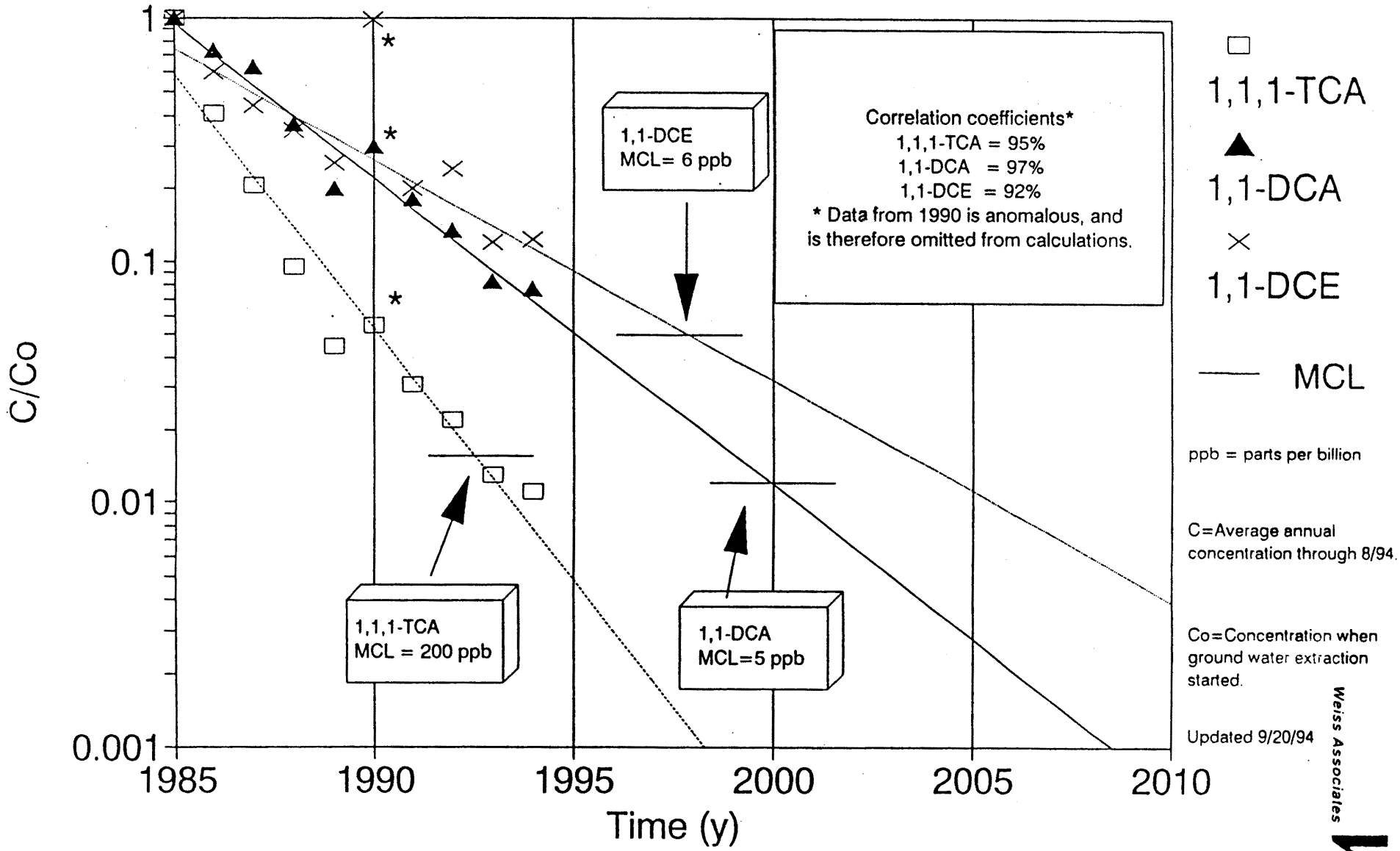

Figure 3 Semi-log plot of relative concentration versus time - Applied Materials well AM1-1

Applied Materials Well AM1-5E

Relative concentration vs. time

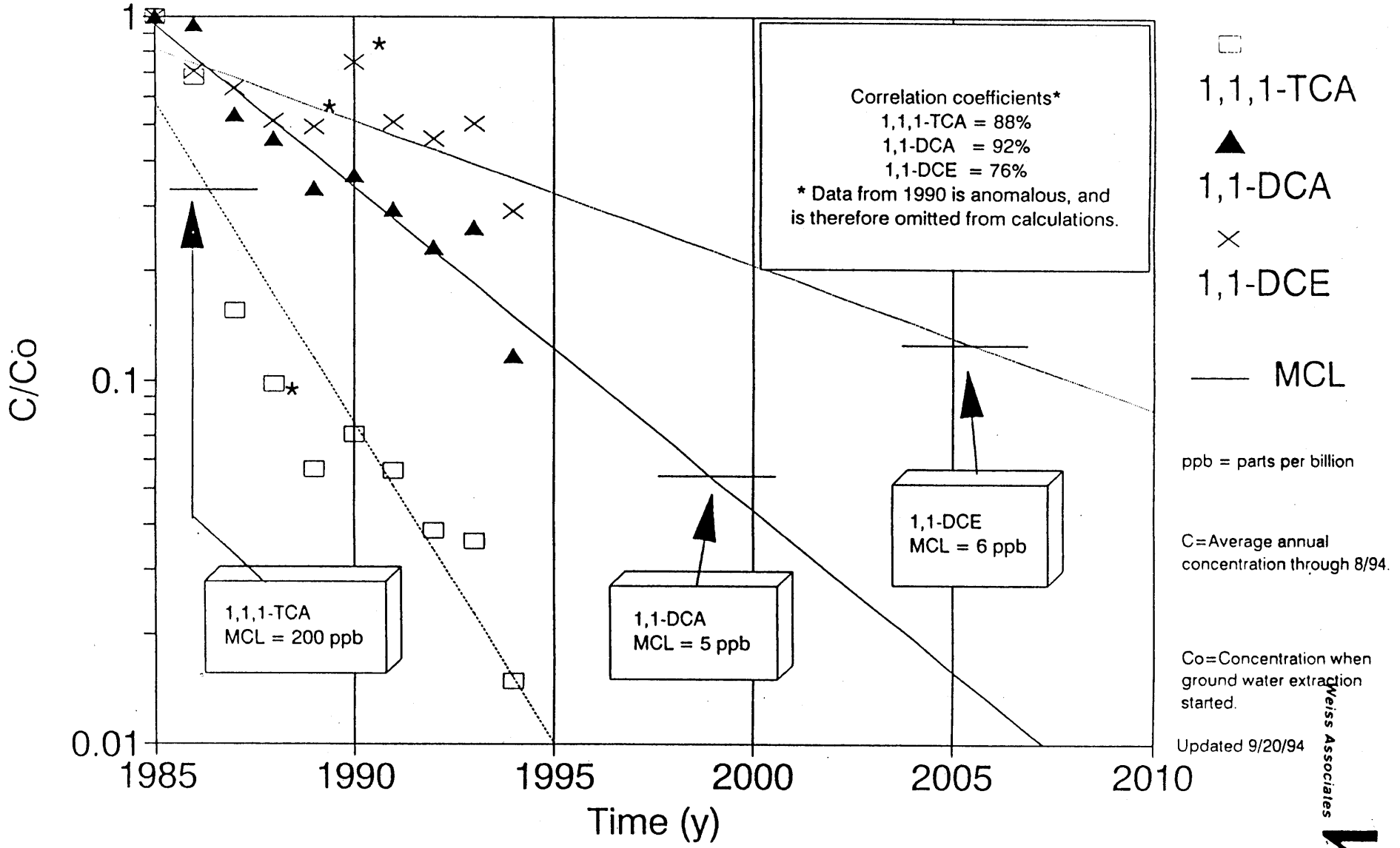

Figure 4. Semi-log plot of relative concentration versus time - Applied Materials well AM1-5E

Applied Materials Well AM1-10
Relative concentration vs. time

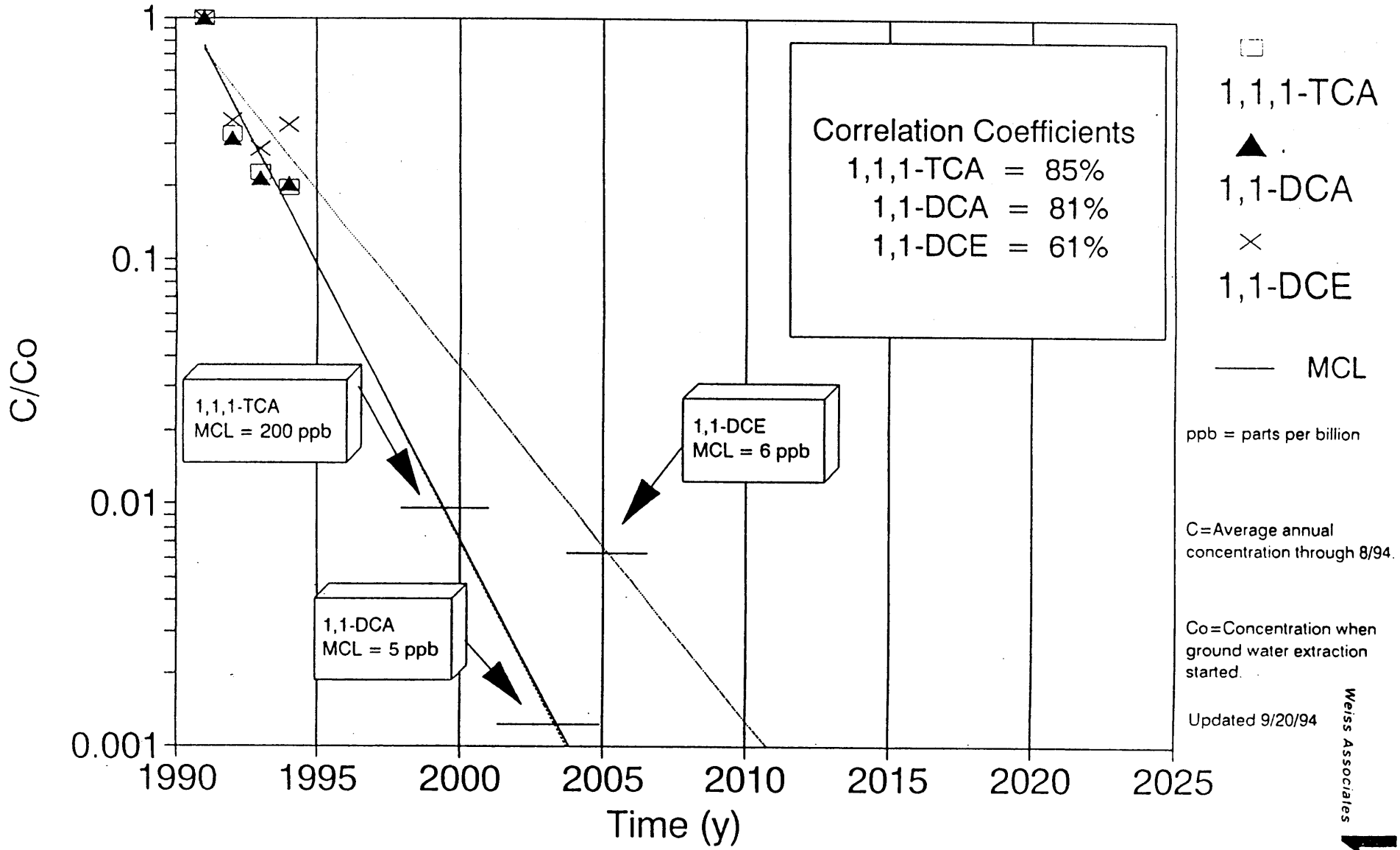

Figure 5 . Semi-log plot of relative concentration versus time- Applied Materials well AM1-10